

**SECTION 20 70 23**  
**ELECTRONIC CIRCUITS, WIRES, AND CABLES**

**PART 1 – GENERAL**

**1.01 SECTION INCLUDES**

- A. Optical transmission cable.
- B. Telephone cables.
- C. Video cable.
- D. Multiple Conductor Control cables.
- E. Thermocouple cables.
- F. Ethernet cable.
- G. Radio cable.

**1.02 RELATED SECTIONS**

- A. Interface and coordinate the work of this Section with:
  - 1. Section 20 70 26, Common Materials and Methods for Electrical Systems.
  - 2. Section 20 50 13, Raceways for Facility Services.
  - 3. Section 26 05 24, Low and Medium Voltage Wires and Cables.
  - 4. Section 20 70 13, Common Materials and Methods for Electronic Services.
  - 5. Section 27 13 01, Communication Cables and Related Equipment.

**1.03 MEASUREMENT AND PAYMENT**

- A. General: Electronic circuits, wires, and cables, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for the related item of work in the Bid Schedule of the Bid Form.

**1.04 REFERENCES**

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM E662      Test Method for Specific Optical Density of Smoke Generated by Solid Materials

## B. California Code of Regulations (CCR):

1. CCR Title 24, Part 3, California Electrical Code

## C. Electronics Industries Association (EIA):

1. EIA 359-A Standard Colors for Color Identification and Coding
2. EIA TIA-455-A Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
3. EIA TIA-455-3 FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
4. EIA TIA-455-13 FOTP-13 Visual and Mechanical Inspection of Fibers, Cables, Connectors and/or Other Fiber Optic Devices
5. EIA TIA-455-25 FOTP-25 Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies
6. EIA TIA-455-30 FOTP-30 Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity
7. EIA TIA-455-41 FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
8. EIA TIA-455-47 FOTP-47 Output Far Field Radiation Pattern Measurement
9. EIA TIA-455-51 FOTP-51 Pulse Distortion Measurement of Multimode Glass Optical Fiber Information Transmission Capacity
10. EIA TIA-455-59 FOTP-59 Measurement of Fiber Point Defects Using an OTDR
11. EIA TIA-455-61 FOTP-61 Measurement of Fiber or Cable Attenuation Using an OTDR
12. EIA 455-88 FOTP-88 Fiber Optic Cable Bend Test
13. EIA 455-91 FOTP-91 Fiber Optic Cable Twist-Bend Test
14. EIA 455-104 FOTP-104 Fiber Optic Cable Cyclic Flexing Test
15. EIA 455-171 FOTP-171 Attenuation by Substitution Measurement - for Short-Length Multimode Graded-Index and Single-Mode Optical Fiber Cable Assemblies
16. EIA TIA- Generic Specification for Fiber Optic Cable 4720000-A

- 17. EIA 492 AAAA      Detail Specification for 62.5- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class 1a Multimode, Graded Index Optical Waveguide Fibers
- 18. EIA TIA-598-A      Optical Fiber Cable Color Coding
- 19. EIA TIA-606      Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- D.      Insulated Cable Engineers Association, Inc. (ICEA):
  - 1. ICEA S-84-608      Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor Technical Requirements
- E.      Institute of Electrical and Electronics Engineers (IEEE):
  - 1. IEEE 383      Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
- F.      National Electrical Manufacturers Association (NEMA):
  - 1. NEMA WC7      Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- G.      National Fire Protection Association (NFPA):
  - 1. NFPA 258      Standard Research Test Method for Determining Smoke Generation of Solid Materials
- H.      Rural Electrification Administration (REA):
  - 1. REA PE-210      Crystalline Propylene-Ethylene Copolymer Raw Material
  - 2. REA 345-67      Filled Telephone Cables
- I.      Underwriters Laboratories Inc. (UL):
  - 1. UL 1581      Electrical Wires, Cables, and Flexible Cords
  - 2. UL 1666      Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

## 1.05 SUBMITTALS

- A.      General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

- B. Submittal Requirements: Before installation of wires and cables, submit the following applicable information for each type and size of wire and cable.
1. Manufacturer of wire and cable, and certificate of compliance;
  2. Number and size of strands composing each conductor;
  3. Conductor insulation composition type in accordance with California Electrical Code and thickness in mils;
  4. Average overall diameter of finished wire and cable;
  5. Minimum insulation resistance in megohms per 1000 feet at 30 degrees Celsius ambient;
  6. Jacket composition and thickness in mils;
  7. Total number of conductors per cable;
  8. Shield material (if any) and thickness;
  9. Conductor resistance and reactance in ohms per 1000 feet at 25 degrees Celsius ambient; and
  10. Conductor ampacity at 30 degrees Celsius ambient for 600 V wire and cable, 20 degrees Celsius ambient earth temperature, 100 percent load factor and conductor temperature of 90 degrees Celsius for wire and cable rated two kV to five kV.
- C. Fiber optic Cable Samples: For fiber optic cables, a 100-foot sample of each optical cable type, single mode and multimode, of the respective sizes indicated, shall be submitted together with full technical specifications for each cable design and construction.

## **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Provide markings on wire and cable in accordance with applicable NEMA and California Electrical Code requirements. Each item shall be labeled with UL listing approval.
- B. Ship each unit securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- C. Store wire and cable in secure and dry storage facility.

## **PART 2 – PRODUCTS**

### **2.01 OPTICAL TRANSMISSION CABLE**

- A. Refer to Section 27 13 01, Communication Cables and Related Equipment.

**2.02 TELEPHONE CABLES**

- A. Conductors: Conductors shall be solid soft or annealed bare copper in accordance with REA 345-67 and ICEA S-84-608. In factory joints, the ends of the conductor shall be butted and shall be free of lumps and sharp projections. The tensile strength of a conductor containing a factory joint shall be not less than 85 percent of the tensile strength of an adjacent section of the solid conductor of equal length that has no joint.
- B. Insulation: Each conductor shall be insulated with a colored, solid, insulating grade propylene/ethylene copolymer meeting the requirements of REA PE-210, Appendix A. The insulation shall be colored to identify the tip and ring conductor of each pair, and each pair in the completed cable. The insulation shall meet the following requirements:
1. Tensile strength, psi, minimum: 3,000
  2. Elongation, percent, minimum: 300
- C. Core Assembly and Unit Binders: In cables having 50 pairs or more, the pairs shall be arranged in groups of 25 pairs. Each group shall be bound with a moisture-resistant string or color-coded tape. Groups may be divided into sub-groups, each of which shall be bound with the binder color assigned to the group. Tapes used as binders shall be non-hygroscopic, non-wicking, and shall be colored. Binders shall be applied with a layer of not more than four inches.
- D. Filling Compound: The filling compound shall be a homogeneous, non-hydroscopic, semi-solid compound formulated to maintain its protective properties throughout normal operating temperatures and over long term aging. The compound shall be uniformly mixed and shall be as colorless as possible for ease of pair identification. The compound shall be free from dirt, metallic particles, and other foreign matter. The compound shall be non-toxic and present no dermal hazards. The compound shall be compatible with all cable components. Fillers shall be gel-filled PE-39 conforming to REA 345-67.
- E. Shield: A minimum of 5 mil copper tape that complies with ICEA S-84-608, including a tinned copper drain wire conforming to PE-39, REA 345-67.
- F. Jacket: Cable jacket material shall not be restricted to the materials specified in PE-39, REA 345-67, but shall be selected along with internal components of the cable assembly.
- G. The completed cable shall comply with the following additional requirements:
1. Low smoke qualification: ASTM E662
  2. Low toxicity qualification: NES 713
  3. Flame retardant qualification: IEEE 383
  4. Halogen content: 0.5 percent by weight, maximum

5. Thickness of jacket: ICEA S-84-608, Paragraph 7.2.2.

- H. Color Coding of Conductors: Conductor color-coding shall be in accordance with Section 26 05 24, Low and Medium Voltage Wires and Cables. Telephone cables shall be color-coded to identify the tip and ring conductors of each pair and to identify each pair in the completed cable.
- I. For Internet Protocol (IP) based Ethernet telephones refer to Section 27 13 01, Communication Cables and Related Equipment.

## **2.03 VIDEO CABLES**

- A. Refer to Section 27 13 01, Communication Cables and Related Equipment.

## **2.04 ETHERNET CABLES**

- A. Refer to Section 27 13 01, Communication Cables and Related Equipment.

## **2.05 MULTIPLE CONDUCTOR CONTROL CABLE**

- A. Provide multiple conductor cable conforming to NEMA WC70, approved for use in cable tray, with the following additional requirements:
  - 1. Number of insulated conductors: As indicated.
  - 2. Insulation: Cable shall be jacketed over the insulation.
  - 3. Overall covering: Cable shall be jacketed over the insulation.
  - 4. Multiple conductors for control wire shall be a minimum of 14 AWG stranded copper.
  - 5. Insulation Rating: 600 V.
- B. Multi-conductor cable shall be made by assembling individual or twisted pairs of insulated conductors into a tight cylindrical form using fillers that are compatible with other materials in the cable. The jacket used shall fit tightly to form a firm assembly.
- C. Multi-conductor cable shall be certified by the manufacturer to have a minimum life of 40 years.

## **2.06 THERMOCUPLE CABLE**

- A. Provide thermocouple cable with solid conductors meeting requirements of ANSI MC96.1 and type-compatible with the thermocouple leads furnished with the motor or temperature sensor. Thermocouple cable shall have flame-retardant insulation, pair-assembled with left-hand lay, with flame-retardant outer jacket, with overall shield, and UL-listed as Type PLTC.

**2.07 RADIO CABLE**

- A. Refer to Section 27 13 01, Communication Cables and Related Equipment.

**PART 3 – EXECUTION****3.01 INSTALLATION**

- A. Coordinate installation of communication circuit wires and cables with the requirements of Section 20 70 26, Common Materials and Methods for Electrical Systems, Section 20 50 13, Raceways for Facility Services, Section 26 05 24, Low and Medium Voltage Wires and Cables, and Section 20 70 13, Common Materials and Methods for Electronic Services.
- B. Fiber optic cables for Train Control and Communication Systems shall be installed as follows:
1. Communication cables between Stations shall be installed in one of the five innerducts in the Communications section of the system wide raceway.
  2. Train control cables between Train Control Rooms or Houses shall be installed in innerducts in the Train Control section of the systemwide raceway.
  3. Lateral cables to Train Control Rooms or Houses shall be installed in separate innerducts.
  4. Communication cables between BART facilities and train control cables from Train Control Rooms or Houses to wayside devices may be without innerducts in the systemwide raceway.

**3.02 IDENTIFICATION**

- A. Identification of wires and cables shall be in accordance with Section 26 05 24, Low and Medium Voltage Wires and Cables.
- B. Labeling: Identification tags or labels shall be provided for each cable. Markers, tags and labels shall use indelible ink or etching which will not fade in sunlight or in duct applications. Markers, tags, and labels shall not become brittle or deteriorate for 30 years. Label all termination panels with cable number or pair identifier for cables in accordance with EIA TIA-606 and as specified. The labeling format shall be identified, and a complete record shall be provided to the District with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

**3.03 TESTING**

- A. General: Testing shall be in accordance with Section 01 45 24, Testing Program Requirements.

- B. For communication related cables, refer to Section 27 13 01, Communication Cables and Related Equipment.

**END OF SECTION 20 70 23**